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Note de recherche

Research Note

Hours-of-Rest Regulations in the Canadian Shipping Industry

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This paper discusses hours of rest for Canadian shipping employees on the basis of statutory regulations, the research literature, and consultations with representatives of the shipping industry during four workshops held in different parts of Canada. Topics include analyses of current regulations, operational practices and research on work and rest and on time of day and rest, and recommendations for change. The analyses found that current regulations do not distinguish between sleep and recreation during rest periods and fail to take into account time of day effects in relation to quality of sleep. The proposed changes in the regulations require the use of non-rotating 24-hour duty schedules providing for minimum rest periods and maximum work periods.

In any industry, hours of work are determined by a number of factors including social custom, technological change, union-employer negotiation, market demand and government regulation. Government regulation is often used in industries where the public interest demands not so much that operators work fewer hours but that they take adequate rest. This is the case in transportation industries where decrement in operator performance

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due to the inadequate hours of rest normally associated with prolonged hours of work can lead to hazardous situations and, occasionally, to catastrophic events. One such catastrophe, the Exxon Valdez incident, led the Public Review Panel on Tanker Safety and Marine Spills Response Capability (1990) to question whether existing Canadian regulations relating to hours of rest for shipping employees were sufficient to prevent a similar event occurring in Canadian waters. As a result, we undertook a review of the existing regulations in the light of current operational requirements and practices in the industry and of recent research in relevant areas. This paper presents a summary of our findings as presented in our report to the Canadian Coast Guard (Buck et al. 1995). We reviewed existing regulations, held four workshops in order to consult representatives of the shipping industry about their operational practices, and reviewed the literature on the duration and scheduling of hours of work and hours of rest.

CURRENT REGULATIONS

Hours-of-rest regulations for the Canadian shipping industry are promulgated by the Canadian Coast Guard under the provisions of the Canada Shipping Act (R.S., c. S-9). The regulations form part of the Safe Manning Regulations (Consolidated Regulations of Canada 1978c) which also regulate staffing levels for ships at sea. As their name implies, these regulations are aimed at promoting safety. Hours-of-work regulations for shipping employees are promulgated by the agency now known as Human Resources Development Canada (previously Labour Canada) under the provisions of the Canada Labour Code Part III (R.S., c. L-1). The regulations include the East Coast and Great Lakes Shipping Employees Hours of Work Regulations (Canada Gazette 1986) and the West Coast Shipping Employees Hours of Work Regulations (Consolidated Regulations of Canada 1978a). They are aimed at promoting acceptable conditions of work, not safety. Thus hours-of-rest and hours-of-work regulations appear in different documents promulgated by different government agencies with different objectives in view. The two sets of regulations also differ in that the hours-of-rest regulations are aimed only at watchkeepers (defined by those regulations as persons "on duty for the purpose of attending to the safe operation of [the] ship"), while the hours-of-work regulations are aimed at all shipping employees. However, the distinction may be moot because the Fire Detection and Extinguishing Equipment Regulations (Consolidated Regulations of Canada 1978b) appear to include all shipping employees as watchkeepers.

The hours-of-rest regulations require

(1) that each watchkeeper receive not less than 6 hours rest per day and not less than 16 hours rest per 2 days;

(2) that unbroken rest taken on each calendar day be at least 6 hours in length;

(3) that the interval between two such unbroken periods of rest be not less than 6 hours and not more than 18 hours; and

(4) that each such unbroken rest be taken within a calendar day except that it may overlap two calendar days if the watchkeeping system by which rest periods are scheduled is based on more than two watches.

The rationale behind this last provision is obscure. The hours-of-work regulations set maximum standard and overtime hours of work on a daily, weekly and voyage basis. While these provisions may make it unlikely that watchkeepers will be required by their employers to work prolonged hours, the regulations do not explicitly prevent it. In fact, the hours-of-work and hours-of-rest regulations taken together permit watchkeepers working under the provision of East Coast regulations to work as much as 114 hours in one 7-day period, and watchkeepers working under the provision of West Coast regulations to work as much as 102 hours.

None of these regulations regulates watchkeeping systems (that is, shift schedules). However, the Ships Deck Watch Regulations (Consolidated Regulations of Canada 1978d) require that watchkeeping systems for deck watches (persons responsible for navigation) must include at least two watches (that is, teams of watchkeepers), each of exclusive membership. There is no comparable regulation for persons responsible for the ship's engines and nor for fire patrols.

OPERATIONAL PRACTICES

We sought data about operational practices in the shipping industry primarily by questioning participants in four workshops. As a secondary source of data, we sent with our invitations to attend the workshops questionnaires relating to the regulations. Responses from 22 persons out of the 116 who were sent questionnaires showed that frequency of observance of the hours-of-rest regulations was rated highly (just over 4 on a 5-point scale) and difficulty of observance only slightly lower. The hours-of-work regulations were rated less frequently observed than the hours-of-rest regulations, partly perhaps because a large proportion of the respondents (39-78 percent, depending on the precise regulation) were unaware that they existed. Similarly, 17 percent of respondents were unaware of the provision of the hours-of-rest regulations relating to overlap of calendar days (listed fourth above).

Attendance at the four workshops consisted of 27 persons out of 116 invited. At the workshops, we recorded opinions about the regulations and

their observance and enforcement, and about attitudes to change in the regulations. Regarding compliance with the hours-of-rest regulations, most participants stated that the regulations were generally acceptable and were observed, although this opinion was not unanimous. Their opinions about prospects for change were more divergent, depending on whether they were, in principle, for or against statutory regulation. Regarding enforcement, participants stated that the enforcing agency (the Canadian Coast Guard) had relatively little influence on the matter. Instead, enforcement was based upon voluntary recognition that persons needed rest, surveillance by union representatives, and the threat of losing insurance cover. In this last respect, it was stated that if an accident or critical incident occurred, insurance companies withdrew cover if they found that the hours-of-rest regulations were not being observed at the time of the incident.

Apart from statutory regulation, participants listed other factors governing hours of work and hours of rest, including technological developments, manning levels, marketing pressures and union contracts. Technological developments had led to work being done at night, for example, contrary to past practices, and to reductions in manning levels which, together with marketing pressures, had made it more difficult to observe hours-of-work and hours-of-rest regulations. On the other hand, technological developments making it easier, for example, to unload cargo within the regulatory constraints of time, and more flexible manning practices such as moving maintenance crews from ship to ship as circumstances demanded, had made it less difficult to observe regulations. Union representatives, as already mentioned, acted to enforce regulations. At the same time, union contracts often called for prolongation of hours of work on the principle that those on board ship might as well work as not work, high wages being what made seafaring attractive.

Hours of work and hours of rest, and more particularly the scheduling of the two, depended also on the task being performed. Persons performing tasks requiring continuous monitoring and control followed 24-hour watchkeeping systems whereas others, notionally at least, worked only during the daytime. In practice, it seemed, some persons performed both watchkeeping and daywork tasks, and some daywork was done at night, so the situation was somewhat more complex than implied by the watchkeeping system. Furthermore, the tasks being performed changed according to whether the ship was in port or at sea, and this caused further disruption in work scheduling. In port, persons otherwise assigned to continuous monitoring tasks were assigned, in addition, to port duties that involved long overtime worked between normal watchkeeping duties (Buck and Webb 1992).

Despite these disruptions in normal scheduling, watchkeeping systems were a significant factor in determining hours of work and hours of rest on

board ship. Participants described to us several such systems. Most were based on a 24-hour day, exceptions being an 8-hours on/8-hours off system based on a 16-hour day found in some river ferry operations and a work-as-required system based on a less-than-24-hour day found in pilotage operations. Most were timed by reference to midnight, an exception being a 16-hours on/8-hours off system used in some towing operations that was timed by reference to the time of leaving port. The most commonly used system was said to be the 4-hours on/8-hours off system, based on three watchkeeping teams, which contrasted with the 6-hours on/6-hours off system (and its variant the 12-hours on/12-hours off system) based on two watchkeeping teams. Colquhoun et al. (1988) likewise reported from their survey of 97 cases of merchant shipping in thirty countries that 52 were of the 4-hours on/8-hours off system and 27 the 6-hours on/6-hours off system. They also reported two cases of the 8-hours on/16-hours off system typical of other industries, but this system was not mentioned by our informants.

It would clearly be advantageous to use well-structured surveys and similarly rigorous techniques for collecting data relating to operational practices in place of the open-ended workshops that we used. Nevertheless, we believe that this general account of current operational practices is substantially correct. Thus we are confident in our conclusion that if proposals were made to change hours-of-work and hours-of-rest regulations, they would be judged by the industry on the basis of their probable effect on prevailing watchkeeping systems.

RESEARCH ON HOURS OF WORK AND REST

Extensive research has been done on the effects of hours of work on performance, beginning with Vernon's study of munition workers in the First World War which showed the value of restricting hours of work to tolerable lengths, that is, to 55.5 hours per week in place of 74.5 hours per week (Vernon 1940). More recently, Rosa et al. (1985) showed that in an experimental work situation experienced data-entry clerks were better able to improve their performance while working an 8-hour/6-day week compared to a 12-hour/4-day week. In an industry-based study of a changeover from 8-hour shifts to 12-hour shifts, Rosa, Colligan and Lewis (1989) reported that data collected before the changeover compared to data collected seven months afterwards showed that test performance varied with time on shift. At the same time they were unable to show any effect on work-based performance data. The operators themselves preferred working 12-hour shifts because they had more days off. At a more informal level, other investigators have reported that operators restrict their hours of work by taking rest pauses on the job. Craig (1984) reported that industrial inspectors

limited the duration of uninterrupted monitoring by taking informal rests, and Hermann (1977) reported that bridge lookouts spent only 48 minutes of each hour actually observing the sea. (This fell to 32 minutes when superior officers were present.)

Morgan, Brown and Alluisi (1974) required experimental subjects to perform a battery of monitoring, target identification and problem-solving tasks. After working continuously for 18 hours, their performance began to deteriorate and continued to deteriorate for the rest of the 42-hour test period. Subjects were then allowed 24 hours rest during which time they reported sleeping between 16 and 18 hours and, as a result, performance was fully restored. Mullaney et al. (1983) found that performance deterioration resulting from 18 hours of continuous work of this kind could be overcome by as little as 6 hours sleep. Whether 6 hours sleep would be sufficient to restore performance if work were done continuously for 18 hours day after day is another question. Data taken from sleep diaries showed that 240 subjects spontaneously slept an average of 7.6 hours each day, with 50-year old subjects recording the least sleep and women recording less than men (Tune 1968). In more exotic circumstances, 29 men working for the British North Greenland Expedition took sleep (virtually whenever they wished) for a mean duration of 7.9 hours per 24-hour period (Lewis and Masterton 1957). In winter and summer with perpetual darkness or light, sleep was more fragmented and not confined to nighttime, but the mean duration remained the same.

Fragmentation raises the important question of whether or not sleep should be taken all in a single period within each 24-hour period. Tune reported that his subjects did not necessarily sleep only once during a 24-hour period. Mullaney et al. (1983) compared the performance of their subjects who worked for 18 hours and then slept for 6 hours with that of subjects who slept for 1 hour after every 6 hours work. On the first day the nappers (those who slept for 1 hour) worked marginally better and on the second day marginally worse. Data taken from sleep diaries showed that 99 sailors involved in solo and double-handed ocean-yacht races slept for periods with a mean length of 2 hours and a minimum length of 10 minutes (Stampi 1989). Race performance was better among those who slept for shorter periods at a time and for a shorter total time each day. Several studies have reported that napping at work, spontaneous or otherwise, is not uncommon (Buck and Lamonde 1993).

From these and other studies (cited by Buck et al. 1995) we concluded that performance can be maintained for a period of 12 hours without significant decrement but not for longer, and that in any case the period should not extend beyond 18 hours without opportunity to sleep. There is no research suggesting how long a schedule requiring a 12-hour

period of work every 24 hours can be maintained. In the short term, the major rest period should allow at least 6 hours sleep in a 24-hour period, but in the longer term (beyond 3 days) it should allow at least 7.5 hours. This sleep need not be taken within a single period but may be divided into two or more shorter periods.

RESEARCH ON TIME OF DAY OF WORKING AND RESTING

Morgan, Brown and Alluisi (1974) and Mullaney et al. (1983) all reported that their results were affected by time of day. Even though their subjects were tired after being awake for more than 24 hours and performance was depressed in consequence, performance improved as midday approached on the second day. This waking-up effect is indicative of a circadian rhythm of performance by virtue of which performance systematically varies through a regular 24-hour cycle, as Bjerner, Holm and Swensson (1955) and Folkard and Monk (1979) showed for real-life industrial tasks. In line with this, industrial operators fall asleep at certain times of day and do this even though they may be at work (Akerstedt 1988). In their review of critical incidents in railway operations, Buck and Lamonde (1993) concluded that incidents were more likely to be related to time of day than to time spent working. In other words, performance was likely to deteriorate in line with time of day even though operators had recently slept.

In circumstances where operations have to be maintained throughout a 24-hour cycle, with the implication that some operators must work at times of day when they would otherwise be asleep, the tendency for those operators to fall asleep while at work can be overcome by having them adopt a new circadian rhythm based upon their work schedules rather than the time markers that normally control the rhythm. That this is possible is demonstrated by the adaptation that follows rapid flight across time zones. Wilkinson (1992) reviewed evidence showing that subjects on permanent night shift inverted their circadian rhythms provided no intervening day of rest disrupted adaptation, and on this basis advocated establishing permanent night shifts. In another review, Knauth (1993) claimed that circadian rhythms were never satisfactorily inverted and concluded that if 24-hour operations are to be maintained it is better for operators not to remain working at the same fixed period from day to day. In other words, a rapidly rotating system was preferable to a permanent system. This latter solution was preferred by shift-working operators who wanted to maintain their social lives adapted to the world around them (Wedderburn 1992). It was also preferred by day-working managers because at some time or other they saw all of their shift-working staff.

If a rotating system is to be used, the question arises as to whether the system should rotate forward or backward. In forward rotation, the rest

period intervening between concluding work at one time of day and beginning work at the next time of day is greater than 24 hours; in backward rotation it is less than 24 hours. Aschoff (1978) observed that if experimental subjects were deprived of knowledge of time of day, they tended to adopt activity rhythms greater than 24 hours. In consequence, they tolerated a lengthening of the working day better than a shortening, and adapted more rapidly to the new regime that followed such a shift. This is one reason why aircrew generally find westward transmeridional flight less stressful than eastward flight. In a marine context, Condon et al. (1988) found that watchkeepers spent more time sleeping on westward voyages. When sailing eastward they compensated for the direction effect by taking longer secondary sleeps. These results suggest that if a rotating system is to be used, forward rotation is preferable.

From these and other studies (cited by Buck et al. 1995) we concluded that performance is better if work is done and sleep is taken at the same time of day during each 24-hour period, and that watchkeeping schedules should be designed accordingly. The relevant studies do not give a clear answer to the question of whether the schedule should provide for operators to work permanently on the same shift (that is, during the same time of day on each day of work) or to rotate between shifts. That being the case, the question has to be resolved by other considerations. However, if these other considerations point to the need for rotating schedules, then rotation should be forward not backward.

A CRITIQUE OF THE CURRENT SITUATION

Our review of the current regulations and of recent research on the duration and scheduling of hours of work and hours of rest suggests that the regulations are deficient in a number of ways. Briefly, the regulations do not allow for adequate sleep, they do not limit hours of work, and they do not address the question of time of day at which work is done and rest is taken.

Regarding adequate sleep, the current provision specifying minimum hours of rest would be adequate in the light of recent research findings if hours of rest were equivalent to hours of sleep, but this is clearly not the case. In fact, hours of rest must include time for recreational activities consisting of, at the very least, time to eat and to pursue personal toilet activities if not to follow other social activities. This point was raised by the Public Review Panel (1990: 27). It does not necessarily follow from this that the hours of rest that must be taken on any given day should be increased. The research findings suggest that operators can tolerate some variability in duration and frequency of sleep, and in the light of variable

operational requirements that may restrict the number of hours available for rest on a given day, that regulation may be left unchanged. Instead, it seems necessary to regulate minimum average hours of rest so that over a longer period average hours of sleep may be maintained in order to avoid a chronic sleep debt.

Regarding hours of work, the current regulations limit hours of work not for reasons of safety but for other reasons, and in doing so permit excessively prolonged hours of work. Excessively prolonged duties may arise from operational practices that, for example, require watchkeepers working on a 4-hours on/8-hours off watchkeeping system to spend the 8-hour period off watch working on other duties. In such circumstances, overtime work (that is, work paid at enhanced rates) is construed as not counting towards total time on watch. What seems required are hours-of-work regulations that parallel hours-of-rest regulations. The research findings suggest that maximum hours of work at any one time should not exceed 18 hours but that over a longer period the average hours of work should not exceed 12 hours per day. The first value matches the current provision requiring at least 6 hours rest per day. The second value, however, does not match the current provision requiring at least 16 hours rest per 2 days.

The failure of the current regulations to address questions relating to time of day at which work is done and rest is taken represents their most critical deficiency. In terms of the current regulations, hours of rest taken at one time of day are equivalent to the same number of hours of rest taken at another time of day, and the research findings show this most emphatically not to be the case. Equally contentious from the point of view of the probable success of these regulations in promoting safety are the assumptions that fatigue, and the time required to recover from fatigue, is a function of number of hours worked, and that when one is not working one is resting (Tepas 1994). The appropriate way of addressing this deficiency is by promulgating regulations relating to work schedules, an approach which, in the shipping industry, would not be particularly innovative. In fact, as our review of operational practices made very clear, work is almost invariably organized on the basis of recognized watchkeeping schedules. What is needed, therefore, is to make these practices mandatory and to specify criteria for selecting between alternative schedules.

PROPOSALS FOR AMENDING THE REGULATIONS

Given the deficiencies in the current regulations relating to hours of rest of shipping employees, we proposed (Buck et al. 1995) that the Safe Manning Regulations should be amended in several ways, beginning with a change in the title of the relevant section (Section 4) from *Hours of Rest*

to *Duty Schedule.* This proposed change of title reflects a change of approach from addressing the duration of rest periods to addressing the manner in which work and rest are scheduled in terms of 24-hour days. To implement this change of approach, we proposed promulgating a regulation requiring that a duty schedule should be published before commencing a voyage. (In the case where this was not done, we proposed that the actual schedule used on the first day of the voyage should be regarded as the published schedule.) This schedule would then determine the times and duration of subsequent hours of work and hours of rest of all watchkeepers. Once assigned to a watch, individuals would maintain their positions on that watch, or would revert to them if operational requirements demanded temporary changes. Regarding temporary changes, we proposed that the times of ending work and rest periods could be delayed, but that the times of beginning work and rest periods could not be advanced. (This represents rotation forward rather than backward.) For example, if overtime were worked the period of work could be extended but it could not begin earlier than scheduled. However, given the vagaries of operational requirements we proposed allowing some flexibility in that respect by allowing the period of work to begin earlier than scheduled up to a limit of 1 hour.

We proposed that the regulations should specify the criteria to be used in designing the duty schedule, first among which would be the use of a 24-hour day. Our review of operational practices showed that this criterion would not be innovative, although it would preclude some schedules that appear to be currently in use. Regarding the question of whether schedules should be permanent or rotating, we noted that seafarers, unlike most non-seafarers, do not leave their place of work and do not have to conform to the social life of another community with a different time frame. We therefore took the view that schedules should be of a permanent, non-rotating, design. In addressing the question of transmeridional voyages across time zones, for voyages in a westward direction, we proposed that forward rotation of watches should be permitted, but for voyages in an eastward direction the ship should adopt the local time of the destination port on setting sail, at least for the purpose of establishing the watchkeeping schedule, and thus avoid the need for backward rotation of watches.

This left the question of duration of work and rest periods within the 24-hour duty schedule. We proposed that hours of work should be limited to 18 hours in any one 24-hour day and 24 hours in any period of 2 days. In line with this, we proposed that hours of rest should be not less than 6 hours in any one 24-hour day and 24 hours in any period of 2 days. Thus we returned to the original question of adequate hours of rest. We had, however, set the answer within the context of 24-hour duty schedules rather than attempting to address it as a straightforward question in its own right.

Finally the limitations of our proposals should be noted. One major question not addressed is the definition of a voyage. Is it, for example, a journey from one port to another, or a continuous period of service spent on board, whether at sea or in port? Our review was confined to research dealing with acute conditions of work and rest and did not deal with chronic sleep loss associated with prolonged periods at sea, nor with the disruptive effects of time spent in port. This question, like others outlined in our report to the Canadian Coast Guard, requires further examination.

THE ROLE OF A REGULATORY APPROACH

Fatigue is a complex phenomenon that is related to, among other factors, workplace design and environmental conditions. Poorly designed instruments, poorly laid out workspaces, and the need to adopt fatiguing postures on the one hand, and shipboard conditions that make if difficult, for example, for watchkeepers to maintain their postures in heavy seas or to obtain sleep of adequate quality on the other, all generate fatigue. That being so, the problems associated with fatigue need to be addressed by techniques of several kinds. Statutory regulation is one such technique.

Regulations like the Safe Manning Regulations are intended to reduce the probability of transportation accidents by decreasing performance decrements associated with fatigue. The rationale underlying them is reflected in statements such as "the overwhelming majority of tanker accidents are caused by human error" and "crew fatigue due to inadequate manning is the most significant cause of accidents" (Public Review Panel 1990: i, 26). Given that approach, well-formed regulations, based, as we propose in this paper, on sound research undoubtedly contribute to that objective.

▮ REFERENCES

AKERSTEDT, T. 1988. "Sleepiness as a Consequence of Shift Work." *Sleep*, Vol. 11, 17-34.

ASCHOFF, J. 1978. "Features of Circadian Rhythms Relevant for the Design of Shift Schedules." *Ergonomics*, Vol. 21, 739-754.

BJERNER, B., A. HOLM and A. SWENSSON. 1955. "Diurnal Variation in Mental Performance: A Study of Three-shift Workers." *British Journal of Industrial Medicine*, Vol. 12, 103-110.

BUCK, L. and R. WEBB. 1992. "Arctic Tanker Risk Analysis: Human Factors." Report prepared for Canarctic Shipping Company, Ottawa. Milton, Ontario: Humansystems Incorporated.

BUCK, L. and F. LAMONDE. 1993. "Critical Incidents and Fatigue Among Locomotive Engineers." *Safety Science*, Vol. 16, 1-18.

BUCK, L., M. GREENLEY, D. LOUGHNANE and R. WEBB. 1995. "Review and Revision of the Safe Manning Regulations." Report prepared for the Transportation Development Centre, Montréal. Milton, Ontario: Humansystems Incorporated.

CANADA GAZETTE. 1986. East Coast and Great Lakes Shipping Employees Hours of Work Regulations, 1985. Part II 120, 1037-1038.

COLQUHOUN, W.P., J. RUTENFRANZ, H. GOETHE, B. NEIDHART, R. CONDON, R. PLETT and P. KNAUTH. 1988. "Work at Sea: A Study of Sleep, and of Circadian Rhythms in Physiological and Psychological Functions, in Watchkeepers on Merchant Vessels. I. Watchkeeping on Board Ships: A Methodological Approach." *International Archives of Occupational and Environmental Health*, Vol. 60, 321-329.

CONDON, R., W.P. COLQUHOUN, P. KNAUTH, R. PLETT, B. NEIDHART, D. DEVOL, S. EICKHOFF and J. RUTENFRANZ. 1988. "Work at Sea: A Study of Sleep, and of Circadian Rhythms in Physiological and Psychological Functions, in Watchkeepers on Merchant Vessels. V. Effects of Time Zone Crossings." *International Archives of Occupational and Environmental Health*, Vol. 61, 39-49.

CONSOLIDATED REGULATIONS OF CANADA. 1978a. Chapter 992: West Coast Shipping Employees Hours of Work Regulations. C.R.C. 10, 7711-7712.

CONSOLIDATED REGULATIONS OF CANADA. 1978b. Chapter 1422: Fire Detection and Extinguishing Equipment Regulations. C.R.C. 15, 11877-11952.

CONSOLIDATED REGULATIONS OF CANADA. 1978c. Chapter 1466: Safe Manning Regulations. C.R.C. 17, 12831-12835.

CONSOLIDATED REGULATIONS OF CANADA. 1978d. Chapter 1481: Ships' Deck Watch Regulations. C.R.C. 17, 12985-12992.

CRAIG, A. 1984. "Human Engineering: The Control of Vigilance." *Sustained Attention in Human Performance*. J.S. Warm, ed. New York: Wiley.

FOLKARD, S. and T.H. MONK. 1979. "Shiftwork and Performance." *Human Factors*, Vol. 21, 483-492.

HERMANN, R. 1977. "Two Studies for Optimizing Operating Bridges and their Application in Inland and Sea Navigation." *Human Factors in the Design and Operation of Ships*. D. Anderson, H. Istance and J. Spencer, eds. Stockholm: Ergonomilaboratoriet.

KNAUTH, P. 1993. "The Design of Shift Systems." *Ergonomics*, Vol. 36, 15-28.

LEWIS, H.E. and J.P. MASTERTON. 1957. "Sleep and Wakefulness in the Arctic." *Lancet*, Vol. 1957-1, 1262-1266.

MORGAN, B.B., B.R. BROWN and E.A. ALLUISI. 1974. "Effects on Sustained Performance of 48 Hours of Continuous Work and Sleep Loss." *Human Factors*, Vol. 16, 406-414.

MULLANEY, D.J., D.F. KRIPKE, P.A. FLECK and L.C. JOHNSON. 1983. "Sleep Loss and Nap Effects on Sustained Continuous Performance." *Psychophysiology*, Vol. 20, 643-651.

PUBLIC REVIEW PANEL ON TANKER SAFETY AND MARINE SPILLS RESPONSE CAPABILITY. 1990. *Protecting our Waters*. Ottawa: Queens Printer for Canada.

ROSA, R.R., D.D. WHEELER, J.S. WARM and M.J. COLLIGAN. 1985. "Extended Workdays: Effects on Performance and Ratings of Fatigue and Alertness." *Behavior Research Methods, Instruments and Computers*, Vol. 17, 6-15.

ROSA, R.R., M.J. COLLIGAN and P. LEWIS. 1989. "Extended Workdays: Effects of 8-hour and 12-hour Rotating Shift Schedules on Performance, Subjective Alertness, Sleep Patterns, and Psychosocial Variables." *Work and Stress*, Vol. 3, 21-32.

STAMPI, C. 1989. "Polyphasic Sleep Strategies Improve Prolonged Sustained Performance: A Field Study on 99 Sailors." *Work and Stress*, Vol. 3, 41-55.

TEPAS, D.I. 1994. "The Special Relevance of Research on Shiftworkers Employed in Manufacturing to Work Schedule Problems in the Transportation Industry." *Proceedings of the 12th Triennial Congress of the International Ergonomics Association*, Vol. 5, 26-27.

TUNE, G.S. 1968. "Sleep and Wakefulness in Normal Human Adults." *British Medical Journal*, Vol. 1968-2, 269-271.

VERNON, H.M. 1940. *The Health and Efficiency of Munition Workers*. Oxford: OUP, 17-18.

WEDDERBURN, A.A.I. 1992. "How Fast Should the Night Shift Rotate? A Rejoinder." *Ergonomics*, Vol. 35, 1447-1451.

WILKINSON, R.T. 1992. "How Fast Should the Night Shift Rotate?" *Ergonomics*, Vol. 35, 1425-1446.